DISCUSSION PAPER SERIES

IZA DP No. 5436

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January 2011

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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Discussion Paper No. 5436
January 2011

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January 2011

ABSTRACT

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This paper contributes to existing work on innovation by studying the determinants of various types of interaction between a firm and its external environment. In particular, it focuses on face-to-face interactions carried out through international business visits. The results indicate that accessing external knowledge is a key determinant of the decision to interact, regardless of the chosen form of interaction. Conferences and trade fairs are the interactions with the highest probability of knowledge gain, while visits to new customers and suppliers are those with the lowest. The likelihood of accessing external knowledge is also affected by the type of employer and functional unit involved, and the characteristics of the employee carrying the visit out. The results support that labour mobility aimed at interacting can add to an organisation's efficient use of human resources. As a result, it highlights that cutting travelling budgets to reduce financial expenditures also reduces opportunities to interact and, with it, the access to external knowledge.

JEL Classification: F2, J6

Keywords: external knowledge, face-to-face interactions, international business visits

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* This paper is part of a research project funded by ARC grant no. LP 0561107 and the Department of Immigration and Citizenship (DIAC). I thank Stephane Mahuteau for valuable comments, and Gregory Ainsworth and Matias Vaira for excellent research assistance. The usual disclaimer applies.

1 Introduction

Research on the sources of innovation and innovation survey data concur that the knowledge used by firms for new products and applications typically exists or is originally developed outside, rather than within, the successful innovator (e.g. Mueller, 1962; March and Simon, 1958; Mansfield, 1968; Rosenberg and Steinmuller, 1988). As a result, a firm can gain an additional leading edge over its competitors by being able to recognise useful external knowledge to be commercially exploited. This ability, commonly referred to as *absorptive capacity* (e.g. Cohen and Levinthal, 1989; 1990) or *dynamic capability* (e.g. Teece and Pisano, 1997) by the literature on innovation, can be developed by carrying out R&D, engaging directly in production, and investing in advanced technical training, amongst others. This is possible as these activities facilitate the creation of novel linkages between what the firm already knows and the new information acquired. In turn, these new linkages and information expand the firm's problem-solving capabilities and, as in the development of cognitive skills in an individual, enhance further the firm's absorptive capacity and the potential economic benefits from the enlarged knowledge stock.

This virtuous circle of learning from the external environment, internalisation and re-elaboration of knowledge cannot exist without opportunities for interacting with the outside environment (e.g. meeting customers), the professional skills and personal abilities of the people carrying them out, and certain institutional settings that favour easy and speedy two-way communication between the functional units located at the interface with the 'outside world' (e.g. marketing) and those at the core of the firm (e.g. production).

A large literature documents the variety of interactions with the external environment that ultimately have a positive effect on a firm's absorptive capacity: these include formal and informal collaborations with private or government-sponsored research centres like

universities, laboratories or other agencies, arrangements catering for knowledge transfers like M&A activity, licensing, joint R&D, manufacturing or distribution, and the temporary employment of personnel holding key knowledge. These studies, however, tend to identify new knowledge with outcome measures, such as patents or new processes, technologies or managerial practices, that capture only in part activities and choices made by firms in their quest for accessing and exploiting external knowledge. Patents do not account for previous attempts, past failures and other activities that nevertheless enable firms to acquire experience and expertise that proves instrumental in turning a knowledge breakthrough into a commercially successful product or service, even after a substantial time lag. Moreover, it excludes knowledge that is not copyrighted but that still contributes positively to productivity and innovation, like informal exchanges (e.g. Noorderhaven and Harzing, 2008).

In addition, the existing literature on innovation tends to analyse the knowledge outcome of one interaction separately from others that might have been available to the firm. Yet, interactions, especially when costly financially and in management time, are the unlikely result of chance. Firms choose when and how much to interact with the external environment, as well as, most importantly, with whom to interact. Understanding the determinants of such choices appears relevant in the context of globalisation, where firms of all sizes are faced not only with vastly greater opportunities to interact than ever before but also the problem of making strategic choices about which form of interaction to undertake when faced with finite budgets. For firms, higher opportunities to interact also heighten the issue of efficiency in collecting and redistributing knowledge internally across functional units. For governments and their national innovation systems the possibility that interactions result in more knowledge production questions the nature of the existing incentives for such activities. Interaction related costs are currently treated as expenditures, but they might be turn out to be investments in accessing knowledge.

This paper contributes to existing work on innovation by studying the determinants of various types of interaction between a firm and its external environment. In particular, it focuses on face-to-face interactions carried out through international business visits. These are trips lasting for less than 12 months, due to work-related reasons and paid for by the employer in the country of origin (UN, 1998). Their growth has been continuous despite the availability of other forms of communication, including those by distance mode (Button and Vega, 2008). In 2007, they reached a volume of over 400 million people, or about 7% of the world's labour force (e.g. IATA, 2007; NBTA, 2009). The interaction types analysed are visits between an employer and (1) other parts of the same organisation, like a subsidiary, a joint venture, or an affiliated organisation; (2) a company within the same supply chain; (3) new potential customers and/or suppliers; (4) conferences or trade fairs. These four categories arise from the answers given by international business visitors to an *ad hoc* airport survey, which is used as main data source (more on it below).

In addition, for each type of interaction, the paper measures the probability of accessing vital external knowledge, and analyses its determinants. This probability is identified by a 'quasi-objective' measure of knowledge production activity: namely, the interviewee's self-assessment of the counterfactual to what would occur to his/her employer if travel did not take place. This was posed as an open-ended question in the airport survey. About a third of respondents indicate that not travelling leads to a 'loss' of knowledge, like becoming unaware of the industry's latest development or best practice. These answers are used to identify visits aimed at accessing essential external knowledge.

The data used in the empirical analysis come from a survey of 1,982 international business visitors to and from Australia carried out in November 2006. The survey includes information on visitors' demographic and occupational characteristics, the functional unit in which the visitor is employed, the purpose of travel, and the relationship between visiting and visited

organisations. Australia presents an ideal case to study face-to-face interactions through business visits as its system of mandatory landing and departure cards, matched to the visa application in the case of foreign residents, enable the national statistical office to collect information on the entire population flowing in and out of the country. As this information is accessible for research purposes, it is possible to use it as a benchmark to identify the potential biases of survey samples.

The assumption at the core of this paper is that firms make a choice amongst alternative types of interaction when deciding to engage with the external environment. This prior is supported by the fact that every type of employer, from multinational corporations (MNC) to small and medium-sized enterprises with less than 100 employees (SME), from government to non-government organisations (NGO) and universities, make use of visits across all four interaction categories highlighted above. Since the airport survey covers travellers only, visits to another part of the same organisation or to an associated company are used as the reference group.

The results indicate that accessing external knowledge is a key determinant of the decision to interact, regardless of the chosen form of interaction. Conferences and trade fairs are the interactions with the highest probability of knowledge gain (48%), while visits to new customers and suppliers are those with the lowest (15%). These estimated probabilities are not insignificant. The likelihood of accessing external knowledge is also affected by the type of employer and functional unit involved, and the characteristics of the employee carrying the visit out. Interestingly, more frequent interactions are associated with a lower likelihood of knowledge gain. The results suggest that the cost to employers for not interacting includes their access to external knowledge.

The rest of the paper is organised as follows. Section 2 reviews the relevant literature. Section 3 presents the data. Section 4 discusses empirical approach and results. Section 5 concludes.

2 Interactions through business visits and the access to knowledge

The existing literature hardly addresses how face-to-face interactions relate to firms' quest to access external knowledge. This reflects the lack and practical difficulty in developing a comprehensive metric capturing all the activities carried out by firms to do so. The most reliable measures are perhaps objective metrics of productive inputs, like R&D expenditures or the number of scientists and engineers employed, or outcomes, like patents. More recently, innovation surveys have begun collecting information on more subjective measures of knowledge production, like the interviewee's assessment of whether a new process or technology was introduced in a firm, and whether this was new to the firm, the country or the world.

Notwithstanding the challenge of measuring knowledge production, the question of how interacting relates to accessing knowledge is framed by two separate literatures. The first focuses on the role of people's mobility in enacting international knowledge transfers. Here knowledge includes both disembodied features, which make it codifiable and replicable through blueprints, and embodied characteristics, like ability and experience, that are inextricably connected with the individual learning, sharing or using the knowledge (e.g. Polanyi, 1966). Existing and emerging 'human channels' of international knowledge transfer[1] include international students (e.g. Park, 2004), employees moving institutions and firms or between firms (e.g. Zellner, 2003; Franco and Filson, 2000), and informal and social networks of people (e.g. Dahl and Pedersen, 2004; Singh, 2005). A particular sub-set of this literature focuses on knowledge transfers within the same organisation, generally between the headquarters of a MNC and its subsidiaries carried out through expatriates (e.g. Collings, Scullion, Morley, 2007) but also vice-versa (e.g. Riusala and Suutari, 2004). Less common is

[1] Other channels of knowledge transmissions are foreign direct investments and the international trade of goods (e.g. Dowrick and Rogers, 1995).

the study of the role of international business visitors. The few existing analyses have shown that this channel is more effective than long-term relocations in transferring information within MNCs (Minbaeva and Michailova, 2004), and that, at the sectoral level, making a visit has a stronger positive effect on the sending country's multifactor productivity than receiving one (e.g. Dowrick and Tani, 2011).

The second group of studies relevant to analyse the link between interacting and accessing external knowledge focuses on the features that help creating a causal relation between the former and the latter. These features can be reduced to face-to-face communication, spatial proximity, and the duration of the interaction.

There is little doubt that face-to-face interaction is the critical 'first step' in the path leading to a knowledge exchange. Its main feature is to enable participants to communicate directly with each other, to ask questions, and to clarify possible misunderstandings in a timely fashion. This is particularly important when the visitors and the visited do not share the same culture and language, as is often the case for international business visitors. Face-to-face communication is not limited to spoken language but encompasses the other senses (especially vision), and provides context to communication (e.g. firm or soft handshake, facial expressions and reactions to conversation, body movement, gesticulation...) that is essential to develop empathy, if any, with the interlocutor, and vice-versa. Research has shown that even when alternative forms of communication exist (e.g. telephone and emails, videoconferencing), face-to-face interaction remains the most effective because it makes participants decide immediately whether to trust each other (e.g. Gambardella, 1988; Storper and Venables, 2004). If mutual trust is established, then reciprocal understanding and cooperation can increase, as the transaction costs and uncertainty associated with sharing knowledge are lower. This facilitates exchanges of information and tacit knowledge (Hansen, 1999; Amin and Cohendet, 2004). It also helps the creation of 'social capital' and networks

(Portes, 1998; Burt, 1997). When there is trust between firms, the range of communication means used expands, though interacting face-to-face remains the preferred mean when interdependent activities need to be coordinated (e.g. Mu, Peng and Love, 2008).

Spatial proximity is also essential to access external knowledge, though its relevance becomes less important once a collaborative relationship has been established. Yet, its role is more than contextual to being a pre-condition for face-to-face communication. For once, co-location favours becoming aware of what is taking place in the neighbourhood, through the higher chance of encountering key people or information and data accidentally, or being exposed to relevant local public knowledge and gossip, shared customers and suppliers, consultants, local institutions and organisations. On the other side, spatial proximity enables the creation of networks amongst people, which continue to exist even when individuals are no longer near to each other. For example, it has been shown that the number of joint patents between a scientist and his/her previous workplace can be as much as 50% higher when the inventor worked there than if s/he did not (Agrewal, Cockburn and McHale, 2006). Institutional programmes promoting the international mobility of researchers (e.g. the 'Erasmus' programme in the EU) are based on the same principle that a temporary stay in a foreign laboratory favours the professional development of young researchers as well as their future opportunities for international collaborations regardless of where they will be located (e.g. Ackers, 2005).

More controversial is the influence of the duration of interacting. Firms wanting to access external knowledge seem able to do so without having to establish a permanent functional unit or activity focused on this purpose. Research has shown that when agents do not face a time constraint for interacting, as in the case of permanent geographic co-location, the knowledge acquired by a firm through its network can remain within the supply chain and not spread to the neighbourhood (Gallie, 2009). At the same time, significant knowledge flows

can result from very short encounters, like those taking place during trade fairs and conferences (e.g. Bathelt and Schuldt, 2008), and short academic visits (e.g. Hamermesh, 2006). A short initial interaction can develop into a long-lasting collaboration thanks to the communication 'pipelines' established during the first visit.

The insights of these two streams of work are relevant for selecting some of the explanatory variables for the empirical analysis and the reference groups when these are categorical. They are also useful to contextualise the use of a quasi-objective measure of knowledge production, which is constructed from the answers to a large survey of international business visitors.

3 The airport survey and the measurement of knowledge

The survey was carried out in November 2006 across four of Australia's international airports: Sydney, Melbourne, Brisbane and Adelaide. These account for over 80% of the volume of international travel from and to Australia. Travellers were approached at the boarding gates after immigration and passport controls by licensed surveyors. Respondents were initially asked whether they were travelling for work-related purposes. Only upon an affirmative response, the interview continued. Overall, 1,016 Australian residents and 966 foreign residents returning home were interviewed. Non-response was minimal (less than 5% of those approached), and only one employee per organisation was interviewed.

Age, gender, occupation, and country of origin of the respondents were compared with a second random sample of departure and landing cards of business visitors during the same period, which was carried out by Australia's Department of Immigration and Citizenship (DIAC), and the population of business visitors in the same year. With the exception of an over-representation of travellers to and from New Zealand, the characteristics of the respondents of the airport survey resulted very similar to those of the people sampled by DIAC and the overall population (for details see Tani, 2010). The airport survey revealed that

business visitors share similar personal and occupational characteristics. They are mostly males, aged between 35 and 44, professionals or managers employed by either a multinational company or a small-medium sized firm with less than 100 employees. The functional units most commonly engaged in business visits are production, strategy and training. Less relevant is the presence of those working in sales and marketing. Respondents are mostly specialist managers, IT professionals and scientists and engineers. There is also a significant number of health specialists working for government and NGOs, typically providing medical and other health relief to areas in less developed countries.

The airport survey shows that each type of employer uses international business visits to interact in each of the four major categories identified (Table 1): these are visits to other parts of the same organisation or affiliate, to parts of the same supply chain, to new customers and suppliers, and to conferences and trade fairs. Finding that each type of employer uses visits across these interaction types suggests that corporations, governments and NGOs are contemporaneously engaged in a variety of interactions with the external environment. As such, they face choices about which one to prioritise or be strategic about, if any, as each employer has have limited financial, time, and human resources.

The identification of 'knowledge' relies on the answer to an open-ended question about the counterfactual to what would occur to the respondent's employer if the visit did not take place. Respondents were not prompted in any way before formulating their answer; they were not told to give a single reason (though they were asked to highlight the most important consequence) or were allowed to give more than one; they were however invited to rank the most important reason if they gave more than one. Their answers could be classified in a handful of broad topics, as illustrated by the sample in Table 2. The author and two other researchers independently organised the responses into five mutually exclusive categories: (1) certain or potential financial losses; (2) separation from the industry's best practice and latest

developments; (3) break-ups, or diminished strength, of an existing relationship with a customer or supplier; (4) other effects, such as legal liabilities stemming from neglecting a contractual responsibility; and (5) no major consequence. The frequency of these answers by type of interaction is reported in Table 3. The most common counterfactual is the fear or certainty of negative financial implications. These tend to include the loss of contracts, inability to beat competitors or to complete a contractual responsibility. The second most common counterfactual is the prospect of 'knowledge loss', seen as the wedge between a continually moving industry's best practice and the employer's competitive position. This motivation is particularly common for visits within the same organisation, and to conferences and trade fairs. The third but distant most common counterfactual is the possibility of negatively affecting an existing relationship. Not making the effort to carry out a visit is generally seen as a sign of no or diminished commitment, particularly in trips to and from Asia.

4 The determinants of knowledge-related IBTs flows

To analyse the determinants of firms' choice of interactions I apply a multinomial logit (MNL) to the interaction type. This approach is motivated by the fact that the interaction type represents a choice between a relatively small number of mutually exclusive alternatives with no particular order of preference of rank. The MNL model also applies to explanatory variables that are case-specific. In other words, their value does not change according to the alternative chosen as might be the case if the same individual were asked to state his or her preferences should s/he choose to interact in each of the four categories. The analysis uses visits within the same organisation as the reference group since this is the form of interaction most discussed by the literature on knowledge transfers (especially when within MNC) and constitute a natural reference group.

Formally, the model estimated is:

$$p(y_i = j) = \frac{\exp(X'_{ji}\beta_j)}{1 + \sum_{l=2}^{m} \exp(X'_{li}\beta_l)}$$

while the reference outcome category is:

$$p(y_i = 1) = \frac{1}{1 + \sum_{l=2}^{m} \exp(X'_{li}\beta_l)}$$

where *i* refers to the observation, *j* is one of the *m* outcomes, X is a set of case-specific regressors that include the features of the visit (number in a year and average duration), its destination and origin, and the demographic, educational, and occupational characteristics of the visitor, including the type of employer, industry, and functional unit. The subscript *m* represents the three other interaction types. The full list of the covariates and their summary statistics are displayed in Table 4. Since all variables are categorical, the mean corresponds to the proportion of observations in the group described relative to the total, and the reference group for variables with multiple categories are highlighted in the description column.

In the empirical analysis I omit trips carried out for purposes classified as 'other'. These contain a heterogeneous group often related to training and briefings for self-employed or within larger organisations (e.g. interviews for promotion/relocation). Although it would be possible to reclassify these observations, their limited number is too small to obtain marginal effects when considered as a separate group.

The estimation is carried out through maximum likelihood methods, and all regressions are performed controlling for heteroskedasticity across sub-groups (robust estimation). The Independence of Irrelevant Alternatives assumption (IIA) is tested with a Hausman test between the unrestricted model containing all categories of the dependent variable and restricted models where these are alternatively excluded. A multinomial probit model is also

estimated, which is not subject to the IIA assumptions. Since both approaches yield very similar marginal effects (available from the author), the discussion focuses on those obtained by MNL.

The top row if Table 5 shows the predicted probability of using business visits to interact. Business visits are most common to another part of the same organisation (predicted probability is 39.8% - not shown), followed by visits within the same supply chain (30.2%), to new customers and suppliers (15.3%) and to conferences and trade fairs (14.7%). The main body of Table 5 reports the marginal effects of the estimates obtained by MNL. These measure the change in the probability of choosing an interaction type relative to the reference group when the explanatory variable is included (more precisely, when its value changes from zero to one.) An effect statistically different from zero at the 1%, 5% and 10% level of significance is highlighted with '***', '**', or '*', respectively.

The results show that there are substantial differences among interaction types depending on the frequency of the interaction, type of employer and functional unit involved, and the characteristics of the employees carrying them out.

Visits within the supply chain are more frequent and longer than those within the same organisation. When the frequency of visits doubles from 2-5 to over 10 each year the probability of visiting a company within the supply chain is about 10% higher than visiting a subsidiary. A similar marginal effect exists when the length of stay is extended from one to three weeks or more per visit. The probability of interacting within the supply chain rises by over 18% if the visit is carried out by a SME rather than a MNC or even a large domestic employer, indicating that the onus of interacting within a supply chain tends to fall on smaller partners. These visits are more likely to be carried out by functional units involved in production (+6%), and significantly less by those in strategy (-10%), than in training, coordination, and sales and marketing (the reference group). These trips are also far more

likely to be carried out by visitors working in manufacturing companies (reference group) vis-à-vis those employed in mining (-9%), utilities (-12%), construction (-15%), transport (-9%), finance (-10%), and culture/recreation (-9%). These results suggest that visits within the supply chain occur as a consequence of the outsourcing of production rather than in later stages of a firm's value added process (e.g. distribution). This is perhaps a consequence of the redistribution of manufacturing jobs towards lower labour-cost economies that has accompanied the globalisation of the world's economy (e.g. Krugman, 2007). This hypothesis is further substantiated by the fact that scientists are less likely to carry out this type of interactions than engineers and those graduated in other fields (include those without a degree) (-6%), who might occupy less field-specific jobs. Australian residents are more likely to carry out these trips than foreign residents (+3% though significant only at the 10% level), suggesting that Australia's small population and large geographic distance from other markets may give its resident firms extra incentives to seek interactions outside the national boundaries, obliging them to sustain the associated costs. In contrast, the probability of visiting part of the supply chain is not affected by the gender of the visitor (-1.5% but statistically insignificantly different from zero), whether one owns the company one works for, and the formal educational level completed.

Interactions with new customers and suppliers are infrequent (-6%) and shorter (+4%) than visits to parts of the same organisation, against the prior that firms constantly try to establish new contacts. SME are more likely than any other type of firm to undertake this type of interaction (+8%). Being a company owner rises the probability of making these visits vis-à-vis being an employee (+8%), as is working in sales and marketing relative to being employed in any other functional unit. This result identifies sales and marketing as the clear main purpose to carry out visits to potential customers and suppliers. The likelihood of this type of interaction is broadly identical across all sectors of the economy (though employment

in the public sector lowers it by 6%), and countries of origin or destination. This suggests that it is a common activity carried out by firms regardless of their sector of activity and host country. However, it is significantly higher for foreign residents, suggesting a stronger effort on their part to penetrate the Australian market, possibly due to the high income per capita of its inhabitants, relative to the flow in the opposite direction. The use of visits to interact with new clients is affected by gender (being a female lowers the probability of these visits by 7%) and the level of formal education (-4% for non-university graduates). No effect instead arises from the field of education, as scientists, engineers, and those graduating from other fields have an almost identical effect on the probability of interacting this way.

Visits to conferences are occasional and relatively short in duration. The marginal effects of an annual trip relative to the reference group is +.07, while it is negative for trips of 6-10 (-.09) or 10 or more annual trips (-.12). The marginal effects of stays of two weeks rather than one are also negative (-.08), and so are those for even longer stays (-.19). By far, the most common employers using business trips to attend conferences and trade fairs are government, NGOs, and universities (+21% relative to any other type of firm), in line with the hypothesis that these events have a clear positive bias towards sharing information, a public good, vis-à-vis rival and excludable information, porducts and services. Yet, those employed in a training function are as likely as those in strategy and sales and marketing to attend conferences and trade fairs suggesting that knowledge access is similarly sought among the various functional units. In contrast, these events are less likely to be attended by those working in production (-4%) and coordination (-6%). The likelihood of interacting through conferences and trade fairs is higher if one works in agriculture (+10%) than in manufacturing, and for those working in construction (+17%), retail trade (+14%), and communication (+9%). It is also substantially higher for women (+5%), scientists (+7%), and those with a PhD (+7%). Being the owner of

a firm does not affect the likelihood of interacting through these activities, nor does the country of residence.

Overall, these results support viewing visits as the consequence of strategic choices made by firms about how to interact with the external environment. The question arising is whether these interactions relate to accessing external knowledge, if at all. The answer can be obtained by estimating the probability of gaining knowledge using the counterfactual from the airport survey. In particular, a dichotomous variable can be constructed, equalling one if non-travelling leads to a knowledge loss (proxying for access to external knowledge) and zero otherwise.

Estimation of this equation is problematic, as it does not take into account the likely simultaneity between whether or not new knowledge is gained and the choice of interaction type. Firms might in fact be more freely share crucial information in visits to a subsidiary than in meeting a new potential customer for a number of reasons: some may be captured by available variables (e.g. firm size), and can be controlled for; others may be unobservable and cause non-random heterogeneity within the interaction categories. This heterogeneity is a source of bias if not controlled for, as it does not account for the higher, non-random likelihood that non-travelling leads to a knowledge loss in the case of visits to parts of the same organisation vis-à-vis those to new clients and suppliers. However, this issue can be overcome by jointly estimating the probabilities of gaining knowledge and the chosen type of interaction to access it. The bivariate probit model provides a natural approach to estimate the system of two simultaneous equations, as it allows the covariance between the error terms of the two equations to differ from zero. Technically, the estimation follows that of models with unobserved limited dependent variables, as defined by:

$$y_1^* = X_1^{'}\beta_1 + \varepsilon_1$$

$$y_2^* = X_2^{'}\beta_2 + \varepsilon_2$$

where y_1^* and y_2^* are unobserved binary outcomes but where the errors ε_1 and ε_2 (jointly normally distributed with means of zero and variances of one) have a non-zero correlation ρ (rho). The two observed outcomes are instead:

$y_1 = \left\{ \frac{1 if y_1^* > 0}{0 if y_1 \leq 0} \right\}$ which represents the relative probability of a knowledge exchange (a binary variable); and

$y_2 = \left\{ \frac{1 if y_2^* > 0}{0 if y_2^* \leq 0} \right\}$ which represents the relative probability of choosing one interaction over another.

If *rho* is zero then the system collapses and the two probabilities can be estimated independently of each other. Since the dependent variable of the second equation contains four categories but the model can be estimated only if this is binary, three separate regressions are estimated. In each, the three binary dependent variables share one category (the probability of carrying out a visit within the same organisation) but its other value represents respectively a visit to:

1. parts of the supply chain (first regression);
2. new clients and suppliers (second regression);
3. conferences and trade fairs (third regression).

The use of the same reference group allows one to better compare the marginal effects of the three sets of results. The estimates are reported in Table 6 while Table 7 displays the associated conditional marginal effects, by interaction type.

For each bivariate probit, the test of independence between the two probabilities is rejected, suggesting that the likelihood of accessing knowledge is not independent of the chosen type of interaction. This result supports using the joint estimation approach undertaken. In particular, with reference to visits to companies within the supply chain and to new clients

and suppliers, the selection is negative, implying that these visits tend to involve less access to knowledge than visits carried out within the same organisation (rho: -.21 and -.268, respectively. Both are highly statistically significantly different from zero). In contrast, the selection for attending conferences and trade fairs is positive and highly statistically significant (rho: .21), implying that these visits are far more likely to lead to knowledge gains than those within the same organisation. The results show that even conditioning on the type of interaction there is a significant use of international business visits to access external knowledge among all types of employers.

The conditional predicted probability of accessing knowledge within the supply chain is 17.6%. In other words, there is a 17.6% chance that knowledge is gained, or, alternatively, that non-travelling mainly creates a knowledge loss, when firms use international business visits for this type of interaction relative to visits within the same organisation. The conditional predicted probability for visiting new clients and suppliers is 14.3%. This is the lowest of the four estimates, but it is not insignificant as it implies that one in six visitors meeting a new client or supplier still does so to access external knowledge. In contrast, the conditional predicted probability for visits to conferences and trade fairs is 47.9%, the highest among those estimated. Not attending the conference or trade fair results in a knowledge loss for almost half of the sample surveyed. This result makes participation to conferences and trade fairs more similar to an investment in accessing external knowledge rather than expenditures or rewards.

The conditional predicted probabilities are also affected by the frequency and duration of the interaction, the type of employer and functional unit involved, and the characteristics of visiting employee. In the case of visits within the supply chain, higher frequencies have a negative marginal effect. Making more visits per annum reduces the likelihood of gaining knowledge by about 7% (from 17.6% to 10.6%). A similar effect is associated to even more

frequent visits. No significant marginal effect is associated with the variables measuring the duration of each interaction. Visits carried out by government, NGOs and the tertiary sector have a positive marginal effect (+.13). This is perhaps not surprising as these trips include visits to international affiliates, like a corresponding foreign university or foreign aid partner, and are carried out by employees working in training functional units. Being a scientist has also a positive marginal effect (+.06), though it has statistical significance only at the 10% significance level. Virtually every sector aside from manufacturing and construction is associated with negative marginal effects, with substantial reductions in the predicted probability of knowledge gains. The most significant are agriculture (-.15), wholesale (-.15) and retail trade (-.07). In contrast, the marginal effects associated with gender, age, and education level are statistically insignificantly different from zero.

The marginal effects obtained for visits to new clients and suppliers are also negative if the annual visits are more frequent than the reference group (2-5), and if they extend over long periods of time (-.07 if the visits lasts 21+ days). Similar to visits within the supply chain, there is a positive marginal effect if the visit is carried out by government, NGOs or universities (+.129), and if visitors work in a training functional unit (+.159). Being a scientist also slightly increases the likelihood of accessing knowledge (+.058). Working in manufacturing, mining, construction, accommodation and finance have similar marginal effects, perhaps as these sectors are the most commonly represented in trips aimed at developing new relationships. In contrast, negative marginal effects are associated with being employed in agriculture (-.146), utilities (-.106), retail trade (-.078), transport (-.075) and culture/recreation (-.108). The conditional predicted probability of visits to new customers or suppliers is not affected by the visitors' country of residence, travel patterns, and ownership of the firm, as the corresponding marginal effects are statistically insignificantly different from zero.

As for the previous cases, the conditional predicted probability for participating to conferences and trade fairs is negatively affected by a high frequency of interaction (-.094 for 10+ visits per annum). Interestingly, too few interactions have also a negative marginal effect (-.065), suggesting the presence of a U-inverted relationship between interacting and gaining knowledge. No effect instead is related to the length of stay, though the negative coefficient of the relevant marginal effect becomes progressively larger and statistically significant if this grows from one week (the reference group) to two (-.025) and three or more (-.033). Working for government, NGOs and universities raises the probability of a knowledge gain (+.11), but the result is significant only at the 10% significance level. On a more stringent significant cut-off, the marginal effect across employer categories is not statistically significant, implying that the likelihood of accessing knowledge in conferences or trade fairs applies regardless of the type of organisation one works for.

Positive marginal effects are associated with working in strategy (+.186), production (+.108), coordination (+.138), and training (+.235). These results further support that conference and trade fairs are opportunities for knowledge exchanges rather than for sales and marketing. Negative marginal effects are associated with finance (-.157) and cultural and recreational services (-.234). This result might be related to the fact that these two sectors are historically characterised by slow productivity growth. For these, conferences and trade fairs might not provide as many opportunities for gaining new knowledge relative to marketing a product or service. As for other types of interaction, the marginal effect associated with the country of residence and travel patterns are statistically no different from zero, suggesting the absence of a geographic bias. Marginal effects insignificantly different from zero are also obtained for the level and field of education, and gender, implying that the likelihood of gaining knowledge in this type of interaction is not specific to discipline, sex or formal qualifications. In contrast, negative significant effects arise for the age groups above 35-44, suggesting that

conferences and trade fairs provide the strongest opportunities to gain knowledge for those of younger ages.

As knowledge gains exist in each type of interaction carried out through international business visits, albeit with different probabilities, all employers have a strong scope to be strategic in choosing the type of interaction as well as allocating well thought budgets and personnel to carry them out.

5 Implications for policy and conclusions

These results show how firms and organisations use international business visits to interact with each other and that access to knowledge motivates their existence regardless of the type of interaction. Macroeconomic studies of international business visits suggest the existence of a positive correlation between visits and productivity/growth. But it is the study of several cases in depth that can reveal how organisations make use of interactions to keep abreast, or push forward, the knowledge frontier. Mobility aimed at interacting, for example through international business visits, can add to an organisation's efficient use of human resources. Unfortunately, qualitative data suggest otherwise. As an example, it is found that business visitors to be managed locally by line managers rather than 'holistically' despite their knowledge and activities are valuable to the whole organisation (e.g. Welch, Welch, and Worm, 2007). Similarly, there are no additional incentives beyond full tax deduction to participate in conferences and trade fairs though organisations and governments generally recognise that a 'knowledgeable' workforce is highly desirable. Cutting travelling budgets reduces financial expenditures. But it also reduces opportunities to interact and, with it, the access to external knowledge.

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Appendix

TABLE 1 CONSEQUENCE OF NOT TRAVELLING BY TYPE OF INTERACTION

	Types of interaction					
Employer ↓	***Pooled data***	***Within same firm***	***Within S-chain***	***1st visit***	***Confer., trade fair***	***Other***
MNC	37%	55%	33%	29%	21%	16%
Large domestic employer	11%	12%	12%	12%	9%	10%
SME	32%	21%	47%	49%	20%	30%
Government, NGO, university	19%	12%	7%	10%	50%	45%
Total	**1,982**	**685**	**535**	**290**	**389**	**83**
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 2 ORGANISING COUNTERFACTUALS: 'RAW' EXAMPLES

Occupation	**Consequence if visit does not take place (recorded answer)**	**Category assigned**
Office Manager and Company Director	I wouldn't be able to keep pace with the head office in US.	Knowledge loss
Marketing Director-consumable goods.	I wouldn't be informed about the new things my company would like to implement next year. My HQ wouldn't be informed about what is going on here.	Knowledge loss
Package Engineer.	Latest trends, in the technology sector we might miss out on common knowledge.	Knowledge loss
Sales Manager.	Wouldn't develop new ideas, less competitive.	Knowledge loss
Company Director Commercial Laundry..	Need to check out latest equipment, keeping up to date.	Knowledge loss
Structural engineer.	Would not be able to design and learn about new techniques, keeps clients happy.	Knowledge loss
Manufacturer of woollen products.	Would not be in touch with market, would not have latest designs.	Knowledge loss
IT Solution Architect	The client would not have received proper training in software .	Knowledge loss
General Manager	No new business if we did not go overseas to keep updated with new techniques and skills for the car industry.	Knowledge loss
Director of Company	Will lose the opportunities to learn new strategies for International business (import and export).	Knowledge loss
Paediatrician	Decrease efficiency/ We're exchanging ideas with hospitals.	Knowledge loss
Miscellaneous Health Professionals	Diminishing of education standards in transplant immunology ie of knowledge sharing in this field.	Knowledge loss
Artists and Related Professionals	Wouldn't see what my colleagues are doing in the world of natural dyes and maintaining an association with one's own intellectual property which is vital.	Knowledge loss

Travel Agent	If we don't travel we're not educated to pass on our knowledge to our clients-can't learn it from a book.	Knowledge loss
Teacher, Professor	Not keeping up with development of science and technology/not up to date.	Knowledge loss

Accountants, Auditors and Corporate Treasurers	Particular client I am visiting wouldn't use us on this occasion.	Relationship loss
Account/Sales Director	No personal contact, no close relationship with clients which eventually means less businesr	Relationship loss
Engineer - Manufacturing Consultant	Business would take longer to start. We are starting a business in China.	Relationship loss
Company Director	long term relationships with senior Management would be weaker.	Relationship loss
IT Manager	Degradation of key client relationship on large contract.	Relationship loss
Earth moving/ tech mechanic.	Would lose reputation as good provider of customer service & consequently may lose business.	Relationship loss
General Manager of wholesale tool company	We would lose the agency if we didn't go this year. We are exclusive agents for their tools.	Relationship loss
Combustion Service Engineer	Bad PR, bad reputation, wouldn't gain as much business.	Relationship loss
IT consultant, software function application.	More difficult to communicate due to our differences, demoralization in relationship.	Relationship loss
Giftware buyer-Manager	I wouldn't have a customer left/ I need to make regular visits to promote product	Relationship loss
Manager of a software co.	The reason we are making this trip is to keep business by establishing a personal relationship. We have a brand new managing director & wish to meet him personally. All the follow-up will be done over the internet. You can't get the same trust without a face to face meeting.	Relationship loss

Vet Surgeon	Lose business. There are a lot of horses travelling between Australia and Hong Kong with Australian raised horses looked after by Australian vets.	Financial loss
General Manager Medical Equipment	Lose money. We have competition and we must keep on with the right decisions. As CEO/owner I have to be there.	Financial loss
Accountant Retail	Lack of co-ordination effects/reduced profits.	Financial loss
Infrastructure Manager/IT	Loss of business due to inability to bring new country on-line.	Financial loss
Master mariner.	They would get someone else in.	Financial loss
Sales Marketing. Marine Industry	Lack of productivity if did not present new projects.	Financial loss
Electrical and Electronics Tradesperson	Failure to get ongoing work from customers (if do not update now on this trip).	Financial loss
National Sales & Marketing	Reduced business and revenue and lack of company growth.	Financial loss

Manager of Australia and NZ		
Photo Digital Production Processor.	Lose a client at least.	Financial loss
Technical Trainer - Telecoms co	Projects would get delayed. Lots of the customers would be looking for compensation as a result.	Financial loss
Race Horse Trainer.	It would cost me a small percentage of business.	Financial loss
Import/Export Director (self employed).	Sales would drop	Financial loss
Antique Dealer (self employed)	No stock, go broke.	Financial loss
Managing director-Advertising Agency	Less profitable - the trip has the potential to substantially increase our turnover.	Financial loss
Sales & marketing-technical IT sales.	It would result in less market exposure & declining customer sales.	Financial loss
IT Consultant	We would lose opportunity to market our company's services.	Financial loss
General Manager for airliner for NZ & Sth West Pacific Region.	We would be unable to generate enough revenue for this region.	Financial loss

TABLE 3 CONSEQUENCE OF NOT TRAVELLING BY TYPE OF INTERACTION

		Types of interaction				
Consequence of not travelling ↓	***Pooled data***	***Within same firm***	***Within S-chain***	***1st visit***	***Confer., trade fair***	***Other***
Financial loss	43.9%	36.1%	62.1%	66.6%	19.8%	25.3%
Miss on best practice	29.6%	30.5%	18.3%	15.2%	53.0%	36.1%
Nothing	12.4%	16.2%	5.4%	9.3%	15.4%	22.9%
Affect relationship	10.4%	11.4%	12.7%	7.6%	8.5%	7.2%
Other	3.6%	5.8%	1.5%	1.4%	3.3%	8.4%
Total	**1,982**	**685**	**535**	**290**	**389**	**83**
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 4 SUMMARY STATISTICS

Code	Mean	Std Dev	Description
EFFECT_K	.293	.455	Dependent variable 1: No travel = no knowledge
WITHIN	.795	.404	Dependent variable selection: 0 = go to conference
EMP_1	.181	.385	Employed by government, NGO, university
EMP_2	.371	.483	Employed by MNC *(reference group)*
EMP_3	.115	.319	Employed by large domestic firm
EMP_4	.324	.468	Employed by SME
FNC_1	.237	.426	Work in strategy department, CEO, owner
FNC_2	.220	.414	Work in production
FNC_3	.204	.403	Work in sales and marketing *(reference)*
FNC_4	.105	.306	Work in coordination (admin, HR, finance)
FNC_5	.138	.345	Work in training
FNC_6	.089	.286	Work in other departments
NR_TRIPS1	.127	.333	Travel internationally once a year
NR_TRIPS2	.426	.495	Travel internationally 2-5 times a year *(refer)*
NR_TRIPS3	.166	.372	Travel internationally 6-10 times a year
NR_TRIPS4	.283	.451	Travel internationally more than 10 times a year
LENGTH_1	.366	.482	Average stay per trip one day
LENGTH_2	.365	.481	Average stay per trip 2-5 days *(reference)*
LENGTH_3	.161	.367	Average stay per trip 6-10 days
LENGTH_4	.100	.300	Average stay per trip 11+ days
ONGOING	.200	.400	Trip is part of series
GENDER	.126	.333	Female
EDU_1	.199	.399	Has high school degree of less
EDU_2	.435	.496	Has university degree *(reference)*
EDU_3	.255	.436	Has Masters' degree
EDU_4	.109	.312	Has PhD
AGE_1	.199	.400	Age <35
AGE_2	.324	.468	Age 35-44 *(reference)*
AGE_3	.304	.460	Age 45-54
AGE_4	.170	.376	Age 55+
DEST_1	.099	.298	Proportion of travellers to/from rest of world
DEST_2	.306	.299	Proportion of travellers to/from Asia
DEST_3	.195	.397	Proportion of travellers to/from Europe/North America
DEST_10	.394	.489	Proportion of travellers to/from New Zealand *(refer)*
NO_S&E	.501	.500	Degree other than science or engineering *(refer)*
SCIENTIST	.213	.410	Scientist
ENGINEER	.287	.452	Engineer
RESIDENCE	.487	.500	Resident outside Australia
D_PUBL	.235	.424	Work for the public sector
N	**1,899**		

TABLE 5 MARGINAL EFFECTS OF MULTINOMIAL LOGIT

Variable	Within S-chain dy/dx	Std err	P>|Z|	New client/supplier dy/dx	Std err	P>|Z|	Conference/trade fair dy/dx	Std err	P>|Z|
Predicted probability	**.301**			**.153**			**.147**		
Nr trips/year:									
Ref: 2-5									
1	-0.111***	0.036	0.002	0.066 *	0.035	0.060	0.091***	0.032	0.005
6-9	0.123***	0.036	0.001	-0.041*	0.022	0.064	-0.093***	0.018	0.000
10+	0.094***	0.031	0.002	-0.030	0.021	0.150	-0.123***	0.018	0.000
Length trip:									
Ref: 2-5									
6-10 days	0.026	0.029	0.379	0.035	0.022	0.107	-0.026	0.019	0.173
11-20 days	0.053	0.039	0.181	-0.008	0.027	0.762	-0.078***	0.020	0.000
21 days-12 mo.	0.074	0.046	0.105	-0.010	0.033	0.769	-0.164***	0.013	0.000
Employer:									
Ref: MNC									
Gov/NGO/ univ	-0.077*	0.045	0.086	0.029	0.039	0.459	0.253***	0.047	0.000
100+ empl	0.047	0.041	0.244	0.048	0.035	0.166	0.044	0.034	0.198
SME (<100 empl)	0.199***	0.032	0.000	0.089***	0.028	0.001	-0.007	0.025	0.778
Functional area:									
Ref: sales & mktg									
Strategy	-0.135***	0.031	0.000	-0.037*	0.022	0.084	-0.007	0.028	0.795
Production	0.043	0.037	0.247	-0.130***	0.018	0.000	-0.047*	0.026	0.071
Coordination	-0.069*	0.040	0.089	-0.129***	0.018	0.000	-0.065***	0.024	0.006
Training	-0.042	0.048	0.374	-0.091***	0.022	0.000	0.006	0.035	0.866
Field education									
Ref: non-S&E									
Scientist	-0.062*	0.032	0.054	0.041	0.028	0.133	0.072***	0.027	0.009
Engineer	-0.002	0.030	0.941	0.020	0.024	0.398	-0.021	0.025	0.402
Female	-0.023	0.040	0.557	-0.071**	0.033	0.030	0.050**	0.026	0.050
Foreign resident	-0.036	0.024	0.133	0.042**	0.019	0.024	0.011	0.018	0.552
Sector dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Origin/destination dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Airport dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Age group dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Education level dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Owner dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nr observations	1,827								
Wald chi	638.1								
LL (model)	-2,042.0								
Pseudo R^2	.1637								

TABLE 6 BINOMIAL PROBIT ESTIMATES - COEFFICIENTS

	Within S-chain			New client/supplier			Conference/trade fair		
	Coeff.	Std err	P>|Z|	Coeff.	Std err	P>|Z|	Coeff.	Std err	P>|Z|
Outcome eq. 1 – knowledge exchange									
Nr trips/year:									
Ref: 2-5									
1	-0.179	0.154	0.243	-0.148	0.154	0.338	-0.108	0.121	0.371
6-9	-0.318 ***	0.118	0.007	-0.272**	0.137	0.047	-0.199	0.130	0.125
10+	-0.267***	0.102	0.009	-0.249**	0.114	0.029	-0.340***	0.112	0.002
Length trip:									
Ref: 2-5									
6-10 days	-0.070	0.101	0.489	0.017	0.112	0.881	-0.070	0.101	0.487
11-20 days	-0.150	0.125	0.231	0.062	0.143	0.664	-0.128	0.130	0.322
21 days-12 mo.	-0.387***	0.147	0.009	-0.281*	0.161	0.081	-0.471***	0.161	0.003
Employer:									
Ref: MNC									
Gov/NGO/ univ	0.294*	0.174	0.091	0.181	0.193	0.348	0.336**	0.146	0.021
100+ empl	0.144	0.128	0.259	-0.041	0.142	0.774	0.142	0.137	0.300
SME (<100 empl)	-0.184*	0.109	0.093	-0.263**	0.133	0.048	-0.080	0.133	0.550
Functional area:									
Ref: sales & mktg									
Strategy	0.277**	0.136	0.041	0.257*	0.146	0.077	0.395***	0.147	0.007
Production	0.172	0.134	0.201	0.210	0.152	0.168	0.162	0.150	0.283
Coordination	0.260*	0.151	0.085	0.289*	0.168	0.086	0.243	0.161	0.131
Training	0.589***	0.176	0.001	0.590***	0.197	0.003	0.488***	0.169	0.004
Field education									
Ref: non-S&E									
Scientist	0.202*	0.120	0.093	0.136	0.128	0.287	0.173	0.112	0.122
Engineer	0.011	0.106	0.916	0.028	0.117	0.809	0.111	0.113	0.328
Female	0.175	0.135	0.194	0.074	0.148	0.618	0.087	0.120	0.472
Foreign resident	0.041	0.083	0.622	0.083	0.090	0.358	-0.024	0.084	0.773
Outcome eq. 2 – Purpose of visit									
Nr trips/year:									
Ref: 2-5									
1	-0.148	0.147	0.316	0.305**	0.151	0.044	0.335**	0.136	0.014
6-9	0.212*	0.110	0.053	-0.210	0.141	0.136	-0.492***	0.146	0.001
10+	0.083	0.097	0.396	-0.173	0.120	0.148	-0.589***	0.130	0.000
Ongoing trip	-0.006	0.109	0.953	0.038	0.127	0.763	0.451***	0.113	0.000
Length trip:									
Ref: 2-5									
6-10 days	0.075	0.093	0.423	0.110	0.109	0.310	0.038	0.106	0.719
11-20 days	-0.006	0.114	0.960	-0.190	0.140	0.176	-0.305**	0.146	0.036
21 days-12 mo.	-0.081	0.129	0.528	-0.244	0.172	0.155	-1.264***	0.224	0.000
Employer:									
Ref: MNC									
Gov/NGO/ univ	0.231	0.168	0.167	0.550***	0.206	0.008	1.101***	0.154	0.000
100+ empl	0.329***	0.122	0.007	0.461***	0.148	0.002	0.387**	0.153	0.011
SME (<100 empl)	0.917***	0.102	0.000	0.824***	0.131	0.000	0.474***	0.145	0.001
Functional area:									
Ref: sales & mktg									
Strategy	-0.589***	0.125	0.000	-0.454***	0.136	0.001	-0.281*	0.157	0.074
Production	-0.136	0.121	0.261	-0.875***	0.151	0.000	-0.467***	0.164	0.004
Coordination	-0.498***	0.143	0.000	-1.178***	0.195	0.000	-0.666***	0.178	0.000
Training	-0.257	0.166	0.121	-0.706***	0.200	0.000	-0.129	0.180	0.473
Field education									

Ref: non-S&E									
Scientist	-0.017	0.114	0.881	0.289**	0.134	0.031	0.219*	0.124	0.079
Engineer	0.033	0.099	0.736	0.026	0.119	0.827	-0.154	0.136	0.260
Female	-0.072	0.131	0.580	-0.338**	0.167	0.044	0.150	0.134	0.265
Sector dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Origin/destination dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Airport dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Age group dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Education level dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Owner dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Atrho	-0.213 *	0.054	0.000	-0.275*	0.067	0.000	0.212***	0.061	0.000
Rho	-0.210*	0.052		-0.268*	0.062		0.209***	0.058	
Nr observations		1,176			946			1,029	
Wald chi		228.6			229.6			370.4	
LL (model)		-1,342.4			-982.8			1,101.0	
Prob > chi2		0.000			0.000			0.000	

TABLE 7 MARGINAL EFFECTS OF CONDITIONAL PROBABILITY – BIPROBIT ESTIMATIONS

	Within S-chain			**New client/supplier**			**Conference/trade fair**		
Variable	**dy/dx**	**Std err**	**P>|Z|**	**dy/dx**	**Std err**	**P>|Z|**	**dy/dx**	**Std err**	**P>|Z|**
Predicted probability	**.181**			**.151**			**.471**		
Nr trips/year:									
Ref: 2-5									
1	-.050	.035	.157	-.020	.035	.573	-.063	.048	.190
6-9	-.071***	.026	.008	-.068***	.026	.009	-.049	.052	.345
10+	-.066***	.025	.009	.065***	.024	.008	-.099**	.045	.028
Length trip:									
Ref: 2-5									
6-10 days	-.016	.026	.553	.009	.027	.721	-.031	.040	.448
11-20 days	-.038	.030	.204	.005	.035	.877	-.032	.052	.532
21 days-12 mo.	-.092***	.029	.001	-.070**	.029	.019	-.104	.065	.109
Employer:									
Ref: MNC									
Gov/NGO/ univ	.098*	.057	.085	.078	.056	.167	.072	.061	.233
100+ empl	.054	.038	.160	.013	.036	.722	.034	.055	.533
SME (<100 empl)	-.015	.030	.612	-.023	.032	.475	-.060	.054	.262
Functional area:									
Ref: sales & mktg									
Strategy	.053	.040	.185	.040	.038	.289	.176***	.058	.002
Production	.042	.038	.272	.005	.039	.894	.095	.061	.117
Coordination	.052	.046	.253	.007	.044	.873	.141**	.064	.028
Training	.175***	.064	.006	.125*	.066	.060	.203***	.065	.002
Field education									
Ref: non-S&E									
Scientist	.056	.036	.115	.050	.034	.147	.057	.046	.213
Engineer	.004	.028	.879	.008	.028	.771	.054	.045	.232
Female	.044	.036	.224	.001	.035	.980	.026	.049	.596
Foreign resident	.011	.022	.622	.020	.022	.359	-.009	.034	.773
Ongoing trip	-.0002	.004	.953	.002	.006	.764	-.028***	.011	.009